Material and Process Development Leading to Economical High-Performance Thin-Film Solid Oxide Fuel Cells

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Objectives

- Demonstrate an SOFC cell that is capable of achieving extraordinarily high power densities at reduced temperatures, and can be produced by cost-effective fabrication processes.

Key Milestones

- Develop anode-supported thin electrolyte cells based on lanthanum gallate electrolyte.
- Demonstrate high cell performance at reduced temperatures.

Approach

The approach is to focus on developing high-performance electrolyte and cathode structures and integrating these structures as thin layers in an anode-supported cell for reduced-temperature (550 to 800°C) operation. High performance electrolyte is based on high-conductivity lanthanum gallate [1, 2]. High cathode performance will be achieved using several approaches, including new materials and engineered microstructures, to significantly improve cathode properties. The materials and fabrication process will be economical, scalable, and amenable to high-volume manufacture of fuel cells. The fabrication method is based on a tape calendering process.

Results

$La_{0.8}Sr_{0.2}Ga_{0.8}Mg_{0.15}Fe_{0.05}O_3$ (LSGMF) electrolyte has been successfully made with a tape-calendering process. Correlation between electrolyte density and sintering temperature/schedule has been established. Initial electrochemical cell performance with thick LSGMF electrolyte, $Sr_{0.5}Sm_{0.5}CoO_3$ cathode and Ni/Ceria anode has been evaluated. Significant lower polarization losses have been obtained for this type of cell, as compared with the conventional cell based on yttria stabilized zirconia (YSZ) electrolyte with lanthanum strontium manganite (LSM) cathode and Ni/YSZ anode (Figure 1). Cell open circuit voltage, electrolyte conductivity, and performance stability of LSGMF-based cell have been evaluated (Figure 2). Anode-supported thin LSGMF electrolyte is being fabricated (Figure 3). Performance evaluation on thin- LSGMF cells is in progress.

Conclusions

Material and process development leading to economical high performance thin-film solid oxide fuel cells program started in July 2001. Promising results have been obtained, based on high conductive electrolytes, high performance cathode materials, and the tape calendering manufacturing process for anode-supported thin LSGMF electrolyte cells. The preliminary results suggest a possible integration of high cathode performance and anode-supported thin LSGMF electrolyte. Successful demonstration of this SOFC can be used as a technology base for the development of 21st century fuel cells, leading to improved fuel cell economics.

References

1. K. Huang, and J. B. Goodenough, *J. Alloys and Compounds*, Vol. 303-304, pp454-464, (2000).
2. T. Ishihara et al., *J. Electrochem. Soc.*, Vol.147, pp1332-1337, (2000).

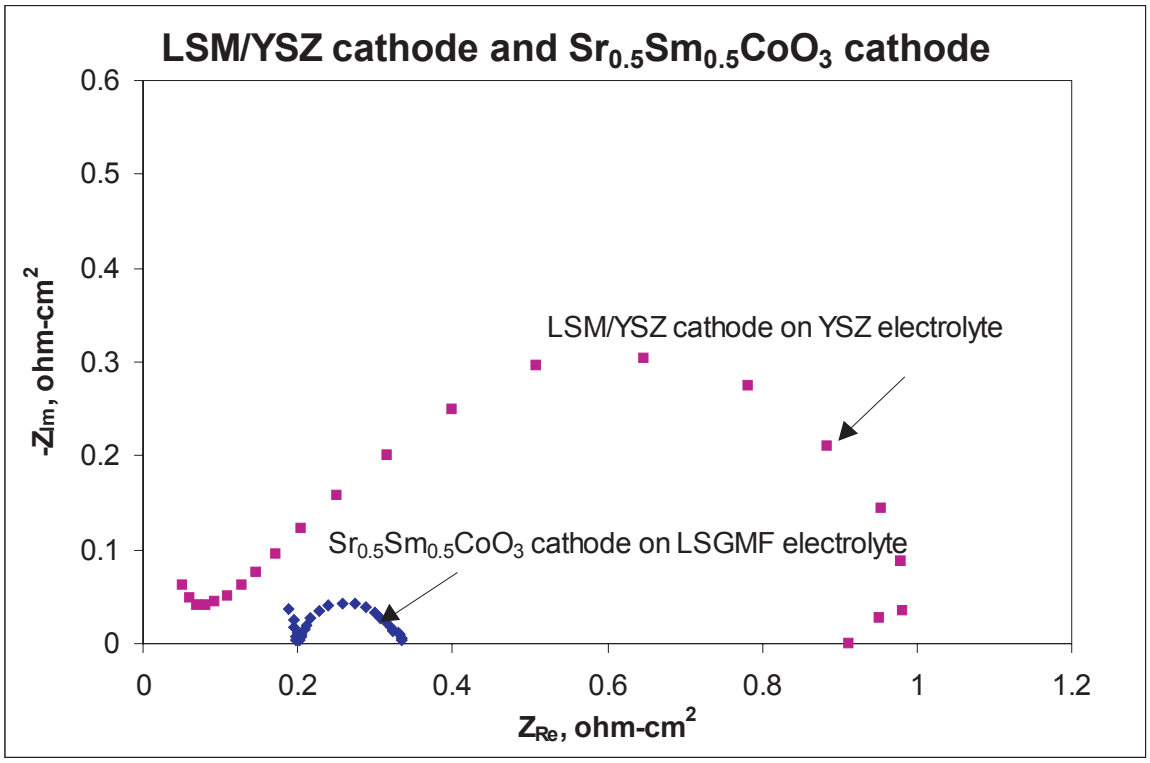

Figure 1: *Performance of cathodes at 800°C.*

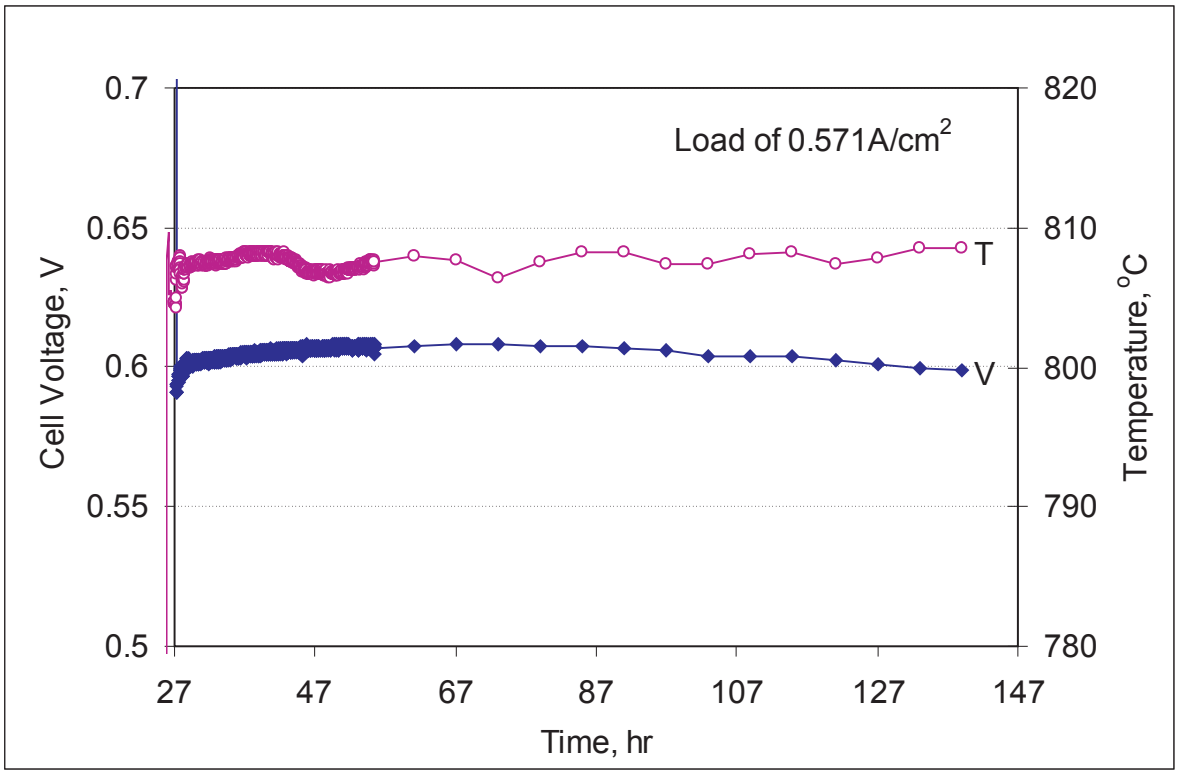

Figure 2: *Cell performance stability with LSGMF electrolyte, $Sr_{0.5}Sm_{0.5}CoO_3$ cathode and NiO/Ceria anode at 800°C.*

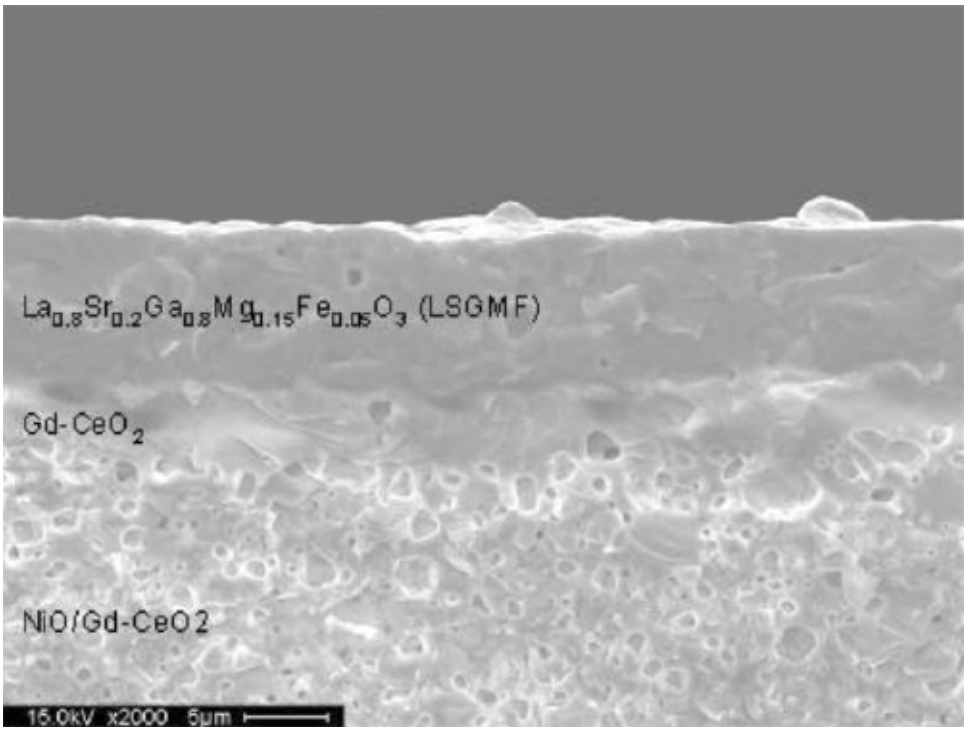

Figure 3: *Anode-supported thin LSGMF electrolyte fabricated using the tape-calendering process.*